4 ENVIRONMENTAL IMPACT ASSESSMENT APPROACH, ASSUMPTIONS, AND METHODOLOGY

This EIS evaluates potential impacts on human health and the natural environment from building and operating a DUF_6 conversion facility at three alternative locations at the Portsmouth site and for a no action alternative. These impacts might be positive, in that they would improve conditions in the human or natural environment, or negative, in that they would cause a decline in those conditions. This chapter provides an overview of the methods used to estimate the potential impacts associated with the EIS alternatives, summarizes the major assumptions that formed the basis of the evaluation, and provides some background information on human health impacts. More detailed information on the assessment methods used to evaluate potential environmental impacts is provided in Appendix F.

4.1 GENERAL APPROACH

Potential environmental impacts were assessed by examining all of the activities required to implement each alternative, including construction of the required facility, operation of the facility, and transportation of materials between sites. Potential long-term impacts from cylinder breaches occurring at Portsmouth and ETTP were also estimated. For each alternative, potential impacts to workers, members of the general public, and the environment were estimated for both normal operations and for potential accidents.

The analysis for this EIS considered all potential areas of impact but emphasized those that might have a significant impact on human health or the environment, would be different under different alternatives, or would be of special interest to the public (such as potential radiation effects). The environmental characteristics of the Portsmouth site, where the conversion facility would be built and operated, are described in Section 3.1. The environmental setting of the ETTP site, where cylinders would be prepared for shipment to Portsmouth, is described in Section 3.2.

The estimates of potential environmental impacts for the proposed action were based on characteristics of the proposed UDS conversion facility. The two primary sources of information were excerpts from the UDS conversion facility conceptual design report (UDS 2003a) and the updated UDS NEPA data package (UDS 2003b). As noted in Section 2.2, current facility designs are at the 100% conceptual design stage. Several design options are considered in the EIS to provide future flexibility.

The NEPA data package (UDS 2003b) was prepared by UDS to support preparation of this EIS. For the proposed Portsmouth conversion facility, the NEPA data package includes facility descriptions, process descriptions and material flows, anticipated waste generation, anticipated air emissions, anticipated liquid effluents, waste minimization and pollution prevention approaches, anticipated water usage, anticipated energy consumption, anticipated materials usage, anticipated toxic or hazardous chemical storage, floodplain and wetland information, anticipated noise levels, estimated land use, employment needs, transportation needs, and safety analysis data.

The NEPA data and a variety of assessment tools and methods were used to evaluate the potential impacts that construction and operation of the conversion facility and shipment of the ETTP cylinders to Portsmouth would have on human health and the environment. These methods are described by technical discipline in Appendix F. The following sections summarize the major assessment assumptions and provide overview information on the estimation of human health impacts from radiation and chemical exposure.

4.2 MAJOR ASSUMPTIONS AND PARAMETERS

Table 4.2-1 gives the major assumptions and parameters that formed the basis of the analyses in this EIS. The primary source for UDS conversion facility data was the updated UDS NEPA data package (UDS 2003b). Discipline-specific information and technical assumptions are provided in the methods described in Appendix F.

4.3 METHODOLOGY

In general, the activities assessed in this EIS could affect workers, members of the general public, and the environment during construction of the new facility, during routine facility operations, during transportation, and during facility or transportation accidents. Activities could have adverse effects (e.g., human health impairment) or positive effects (e.g., regional socioeconomic benefits, such as the creation of jobs). Some impacts would result primarily from the unique characteristics of the uranium and other chemical compounds handled or generated under the alternatives. Other impacts would occur regardless of the types of materials involved, such as the impacts on air and water quality that can occur during any construction project and the vehicle-related impacts that can occur during transportation.

The areas of potential environmental impacts evaluated in this EIS are shown and described in Figure 4.3-1 (the order of presentation does not imply relative importance). For each area, different analytical methods were used to estimate the potential impacts from construction, operations, and accidents for each of the alternatives. The assessment methodologies are described in Appendix F.

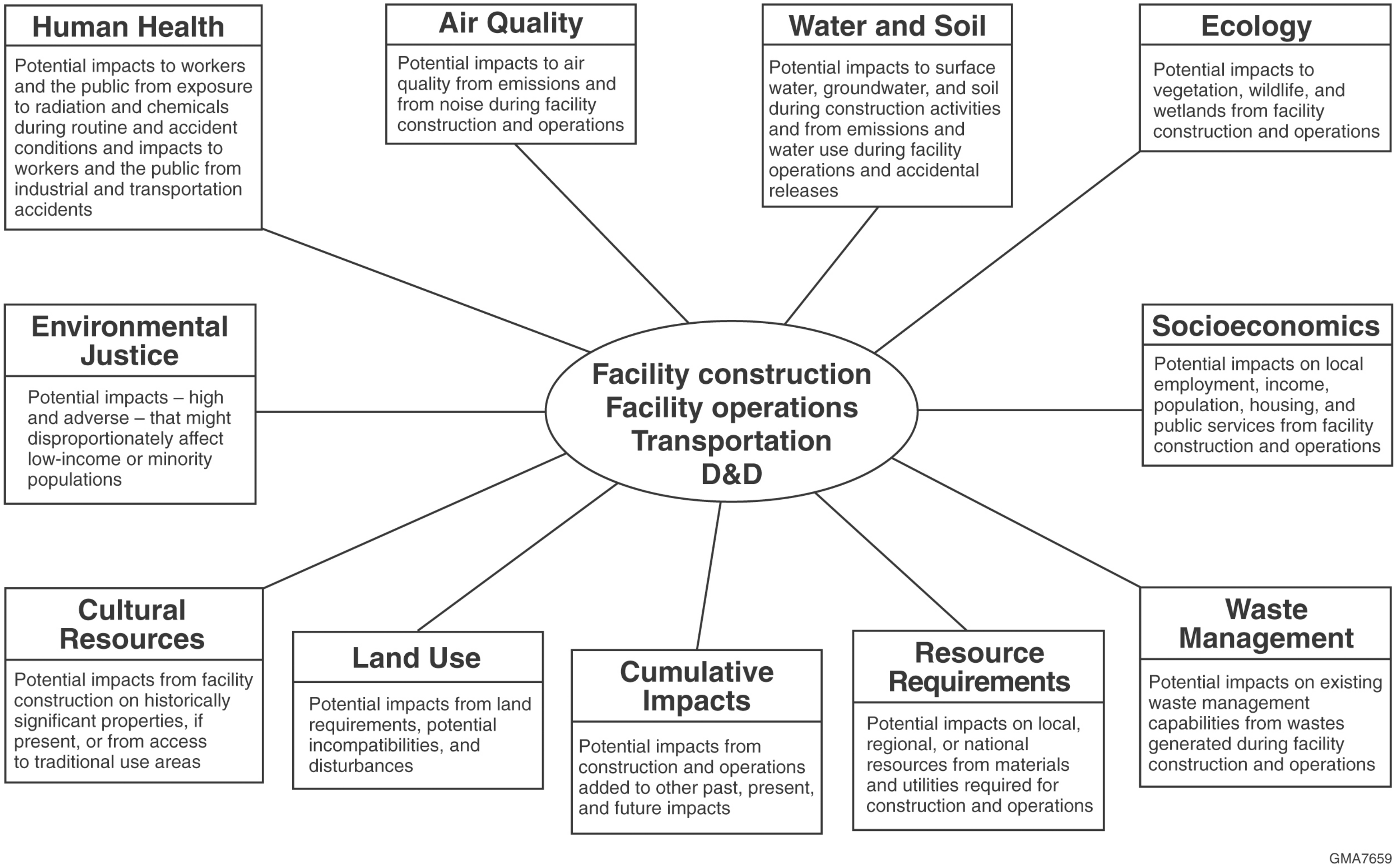
Because of the chemical and radioactive nature of the materials being processed and produced, and the fact that the conversion facility would be built on a previously disturbed industrialized site, the potential impact to the health of workers and the public is one of the areas of primary concern in this EIS. Therefore, the following sections provide background information on radiation and chemical health effects and on the approach used to evaluate accidents. The information is presented to aid in the understanding and interpretation of the potential human health impacts presented in Chapters 2 and 5.

TABLE 4.2-1 Summary of Major EIS Data and Assumptions

Parameter/Characteristic	Data/Assumption
General	
Portsmouth DUF_6 cylinder inventory	16,109 cylinders; 195,800 t
Portsmouth non-DUF_6 cylinder inventory	2,693 cylinders: 13,500 t (14,900 tons)
ETTP DUF_6 cylinder inventory	4,822 cylinders; 54,300 t (60,000 tons)
ETTP non-DUF_6 cylinder inventory	1,102 cylinders; 26 t (29 tons)
No Action Alternative	No conversion facility constructed; continued long-term storage of DUF_6 in cylinders at Portsmouth and ETTP.
Assessment period	Through 2039, plus long-term groundwater impacts
Construction	None
Cylinder management	Continued surveillance and maintenance activities consistent with current plans and procedures.
Assumed total number of future cylinder breaches:	
Controlled-corrosion case	16 at Portsmouth; 7 at ETTP
Uncontrolled-corrosion case	74 at Portsmouth; 213 at ETTP
Action Alternatives	Build and operate a conversion facility at the Portsmouth site for conversion of the Portsmouth and ETTP DUF_6 inventories; construct a new cylinder storage yard at Portsmouth for ETTP cylinders.
Construction start	2004
Construction period	≈2 years
Start of operations	2006
Operational period	18 years (14 years if ETTP cylinders are converted at Paducah)
Facility footprint	10 acres (4 ha)
Facility throughput	13,500 t/yr (15,000 tons/yr) DUF_6
Conversion products	
Depleted U_3O_8	10,800 t/yr (11,800 tons/yr)
CaF_2	18 t/yr (20 tons/yr)
70% HF acid	2,500 t/yr (2,800 tons/yr)
49% HF acid	5,800 t/yr (6,300 tons/yr)
Steel (empty cylinders, if not used as disposal containers)	1,177 t/yr (1,300 tons/yr)
Proposed conversion product disposition (see Table 2.2-2 for details):	
Depleted U_3O_8	Disposal; Envirocare (primary), NTS (secondary)[a]
CaF_2	Disposal; Envirocare (primary), NTS (secondary)
70% HF acid	Sale pending DOE approval
49% HF acid	Sale pending DOE approval
Steel (empty cylinders, if not used as disposal containers)	Disposal; Envirocare (primary), NTS (secondary)

[a] DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional appropriate NEPA review. Accordingly, DOE will continue to evaluate its disposal options and will consider any further information or comments relevant to that decision. DOE will give a minimum 45-day notice before making the specific disposal decision and will provide any supplemental NEPA analysis for public review and comment.

Sources: UDS (2003a,b).



Human Health

Potential impacts to workers and the public from exposure to radiation and chemicals during routine and accident conditions and impacts to workers and the public from industrial and transportation accidents

Air Quality

Potential impacts to air quality from emissions and from noise during facility construction and operations

Water and Soil

Potential impacts to surface water, groundwater, and soil during construction activities and from emissions and water use during facility operations and accidental releases

Ecology

Potential impacts to vegetation, wildlife, and wetlands from facility construction and operations

Environmental Justice

Potential impacts – high and adverse – that might disproportionately affect low-income or minority populations

Socioeconomics

Potential impacts on local employment, income, population, housing, and public services from facility construction and operations

Cultural Resources

Potential impacts from facility construction on historically significant properties, if present, or from access to traditional use areas

Land Use

Potential impacts from land requirements, potential incompatibilities, and disturbances

Cumulative Impacts

Potential impacts from construction and operations added to other past, present, and future impacts

Resource Requirements

Potential impacts on local, regional, or national resources from materials and utilities required for construction and operations

Waste Management

Potential impacts on existing waste management capabilities from wastes generated during facility construction and operations

FIGURE 4.3-1 Areas of Potential Impact Evaluated for Each Alternative

4.3.1 Overview of the Human Health Assessment

Human health impacts were estimated for three types of potential exposures: exposure to radiation, exposure to chemicals, and exposure to physical hazards (e.g., on-the-job injuries or fatalities from falls, lifting, or equipment malfunctions). These potential human exposures could occur in and around facilities or during transportation of materials. Exposures could take place during incident-free (normal) operations or following accidents in the facilities or during transportation.

The nature of the potential impacts resulting from the three types of exposure differs. Table 4.3-1 lists and compares the key features of these types of exposures. Because of the differences in these features, it is not always appropriate to combine impacts from different exposures to get a total impact for a given human receptor.

4.3.2 Radiation

All of the alternatives would involve handling compounds of the element uranium, which is radioactive. Radiation, which occurs naturally, is released when one form of an element (an isotope) changes into some other atomic form. This process, called radioactive decay, occurs because unstable isotopes tend to transform into a more stable state. The radiation emitted may be in the form of particles, such as neutrons, alpha particles, or beta particles, or waves of pure energy, such as gamma rays.

The radiation released by radioactive materials (i.e., alpha, beta, neutron, and gamma radiation) can impart sufficient localized energy to living cells to cause cell damage. This damage may be repaired by the cell, the cell may die, or the cell may reproduce other altered cells, sometimes leading to the induction of cancer. An individual may be exposed to radiation from outside the body (called external exposure) or, if the radioactive material has entered the body through inhalation (breathing) or ingestion (swallowing), from inside the body (called internal exposure).

4.3.2.1 Background Radiation

Everyone is exposed to radiation on a daily basis, primarily from naturally occurring cosmic rays, radioactive elements in the soil, and radioactive elements incorporated in the body. Man-made sources of radiation, such as medical x-rays or fallout from historical nuclear weapons testing, also contribute, but to a lesser extent. About 80% of background radiation originates from naturally occurring sources, with the remaining 20% resulting from man-made sources.

The amount of exposure to radiation is commonly referred to as “dose.” The estimation of radiation dose takes into account many factors, including the type of radiation exposure (neutron, alpha, gamma, or beta), the different effects each type of radiation has on living tissues,

TABLE 4.3-1 Key Features of Potential Human Exposures to Radiological, Chemical, and Physical Hazards

	Potential Exposures		
Feature	Radiological	Chemical	Physical Hazard
Materials of concern	Uranium and its compounds.	Uranium and its compounds, HF, and NH_3.	Physical hazards associated with all facilities and transportation conditions.
Health effects	Radiation-induced cancer incidence and potential fatalities would occur a considerable time after exposure (typically 10 to 50 years). The risks were assessed in terms of LCFs above background levels.	Adverse health effects (e.g., kidney damage and respiratory irritation or injury) could be immediate or could develop over time (typically less than 1 year).	Impacts would result from occurrences in the workplace or during transportation that were unrelated to the radiological and/or chemical nature of the materials being handled. Potential impacts would include bodily injury or death due to falls, lifting heavy objects, electrical fires, and traffic accidents.
Receptor	Generally the whole body of the receptor would be affected by external radiation, with internal organs affected by ingested or inhaled radioactive materials. Internal and external doses were combined to estimate the effective dose equivalent (see Appendix F).	Generally certain internal organs (e.g., kidneys and lungs) of the receptor would be affected.	Generally any part of the body of the receptor could be affected.
Threshold	No radiological threshold exists before the onset of impacts, i.e., any radiation exposure could result in a chance of LCFs. To show the significance of radiation exposures, the estimated number of LCFs is presented, and radiation doses are compared with existing regulatory limits.	A chemical threshold exposure level exists (different for each chemical) below which exposures are considered safe (see Section 4.3.3). Where exposures were calculated at below threshold levels, “no impacts” are reported.	No threshold exists for physical hazards. Impact estimates are based on the statistical occurrence of impacts in similar industries and on the amount of labor required.

the type of exposure (i.e., internal or external), and, for internal exposure, the fact that radioactive material may be retained in the body for long periods of time. The common unit for radiation dose that accounts for these factors is the rem (1 rem equals 1,000 mrem).

In the United States, the average dose from background radiation is about 360 mrem/yr per person, of which about 300 mrem is from natural sources. For perspective, the radiation doses resulting from a number of common activities are provided in Table 4.3-2. The total dose to an individual member of the general public from DOE and other federal activities is limited by law to 100 mrem/yr (in addition to background radiation), and the dose to a member of the public from airborne emissions released from DOE facilities must be below 10 mrem/yr (40 CFR Part 61).

4.3.2.2 Radiation Doses and Health Effects

Radiation exposure can cause a variety of adverse health effects in humans. Very large doses of radiation (about 450,000 mrem) delivered rapidly can cause death within days to weeks from tissue and organ damage. The potential adverse effect associated with the low doses typical of most environmental and occupational exposures is the inducement of cancers that may be fatal. This latter effect is called “latent” cancer fatality (LCF) because the cancer may take years to develop and cause death. In general, cancer caused by radiation is indistinguishable from cancer caused by other sources.

For this EIS, radiation effects were estimated by first calculating the radiation dose to workers and members of the general public from the anticipated activities required under each alternative. Doses were estimated for internal and external exposures that might occur during normal (or routine) operations and following hypothetical accidents. The analysis considered three groups of people: (1) involved workers, (2) noninvolved workers, and (3) members of the general public.

For each of these groups, doses were estimated for the group as a whole (population or collective dose). For noninvolved workers and the general public, doses were also estimated for a MEI. The MEI was defined as a hypothetical person who — because of proximity, activities, or living habits — could receive the highest possible dose. The MEI for noninvolved workers and members of the

Key Concepts in Estimating Risks from Radiation

The health effect of concern from exposure to radiation at levels typical of environmental and occupational exposures is the inducement of cancer. Radiation-induced cancers may take years to develop following exposure and are generally indistinguishable from cancers caused by other sources. Current radiation protection standards and practices are based on the premise that any radiation dose, no matter how small, can result in detrimental health effects (cancer) and that the number of effects produced is in direct proportion to the radiation dose. Therefore, doubling the radiation dose is assumed to result in doubling the number of induced cancers. This approach is called the “linear-no-threshold hypothesis” and is generally considered to result in conservative estimates (i.e., over-estimates) of the health effects from low doses of radiation.

TABLE 4.3-2 Comparison of Radiation Doses from Various Sources

Radiation Source	Dose to an Individual
Annual background radiation — U.S. average	
Total	360 mrem/yr
From natural sources (cosmic, terrestrial, radon)	300 mrem/yr
From man-made sources (medical, consumer products, fallout)	60 mrem/yr
Daily background radiation — U.S. average	1 mrem/d
Increase in cosmic radiation dose due to moving to a higher altitude, such as from Miami, Florida, to Denver, Colorado	25 mrem/yr
Chest x-ray	10 mrem
U.S. transcontinental flight (5 hours)	2.5 mrem
Dose from naturally occurring radioactive material in agricultural fertilizer — U.S. average	1 to 2 mrem/yr
Dose from standing 6 ft (2 m) from a full DUF_6 cylinder for 5 hours	1 mrem

Sources: National Council on Radiation Protection and Measurements (NCRP 1987).

general public usually was assumed to be at the location of the highest on-site or off-site air concentrations of contaminants, respectively — even if no individual actually worked or lived there. Under actual conditions, all radiation exposures and releases of radioactive material to the environment are required to be kept as low as reasonably achievable (ALARA), a practice that has as its objective the attainment of dose levels as far below applicable limits as possible.

Following estimation of the radiation dose, the number of potential LCFs was calculated by using health risk conversion factors. These factors relate the radiation dose to the potential number of expected LCFs on the basis of comprehensive studies of groups of people historically exposed to large doses of radiation, such as the Japanese atomic bomb survivors. The factors used for the analysis in this EIS were 0.0004 LCF/person-rem of exposure for workers and 0.0005 LCF/person-rem of exposure for members of the general public (International Commission on Radiological Protection [ICRP] 1991). The latter factor is slightly higher because some individuals in the public, such as infants, are more sensitive to radiation than the average worker. These factors imply that if a population of workers receives a total dose of 2,500 person-rem, on average, 1 additional LCF will occur among the workers. Similarly, if the general public receives a total dose of 2,000 person-rem, on average, 1 additional LCF will occur.

The calculation of human health effects from radiation is relatively straightforward. For example, assume the following situation:

- Each of 100,000 persons receives a radiation dose equal to background, or 360 mrem/yr (0.36 rem/yr), and

- The health risk conversion factor for the public is 0.0005 LCF/person-rem.

In this case, the number of radiation-induced LCFs caused by 1 year of exposure among the population would be 1 yr × 100,000 persons × 0.36 rem/yr × 0.0005 LCF/person-rem, or about 18 cancer cases, which would occur over the lifetimes of the individuals exposed. For perspective, in the same population of 100,000 persons, a total of about 23,000 (23%) would be expected to die of cancer from all causes over their lifetimes (Centers for Disease Control and Prevention 1996).

Sometimes the estimation of number of LCFs does not yield whole numbers and, especially in environmental applications, yields numbers less than 1. For example, if 100,000 persons were exposed to 1 mrem (0.001 rem) each, the estimated number of LCFs would be 0.05. The estimate of 0.05 LCF should be interpreted statistically — as the average number of deaths if the same radiation exposure was applied to many groups of 100,000 persons. In most groups, no one (zero persons) would incur an LCF from the 1-mrem exposure each person received. In some groups, 1 LCF would occur, and in exceptionally few groups, 2 or more LCFs would occur. The average number of deaths would be 0.05 (just as the average of 0, 0, 0, and 1 is 0.25). The result, 0.05 LCF, may also be interpreted as a 5% chance (1 in 20) of 1 radiation-induced LCF in the exposed population. In this EIS, fractional estimates of LCFs were rounded to the nearest whole number for purposes of comparison. Therefore, if a calculation yielded an estimate of 0.6 LCF, the outcome is presented as 1 LCF, the most likely outcome.

The same concept is assumed to apply to exposure of a single individual, such as the MEI. For example, the chance that an individual exposed to 360 mrem/yr (0.36 rem/yr) over a lifetime of 70 years would die from a radiation-induced cancer is about 0.01 (0.36 rem/yr × 0.0005 LCF/rem × 70 yr = 0.01 LCF). Again, this should be interpreted statistically; the estimated effect of radiation on this individual would be a 1% (1 in 100) increase in the chance of incurring an LCF over the individual's lifetime. In the EIS, the risk to individuals is generally presented as the increased chance that the individual exposed would die from a radiation-induced cancer. As noted, the baseline chance of dying from cancer in the United States is approximately 1 in 4.

4.3.3 Chemicals

For this EIS, the chemicals of greatest concern are soluble and insoluble uranium compounds, HF, and anhydrous NH_3. Uranium compounds can cause chemical toxicity to the kidneys; soluble compounds are more readily absorbed into the body and thus are more toxic to the kidneys. HF and NH_3 are corrosive gases that can cause respiratory irritation in humans, with tissue destruction or death resulting from exposure to large concentrations. Both have a pungent and irritating odor. No deaths are known to have occurred as a result of short-term (i.e., 1 hour or less) exposures to 50 ppm or less of HF, or 1,000 ppm or less of NH_3. Uranium compounds, HF, and NH_3 are not chemical carcinogens; thus, cancer risk calculations are not applicable for the chemical hazard assessment.

For long-term, low-level (chronic) exposures to uranium compounds and HF emitted during normal operations, potential adverse health effects for the hypothetical MEI in the noninvolved worker and general public populations were calculated by estimating the intake levels associated with anticipated activities. Intake levels were then compared with reference levels below which adverse effects are very unlikely. Risks from normal operations were quantified as hazard quotients and hazard indices (see text box).

Key Concepts in Estimating Risks from Low-Level Chemical Exposures

Reference Level

- Intake level of a chemical below which adverse effects are very unlikely.

Hazard Quotient

- A comparison of the estimated intake level or dose of a chemical with its reference dose.
- Expressed as a ratio of estimated intake level to reference dose.
- Example:
  - The EPA reference level (reference dose) for ingestion of soluble compounds of uranium is 0.003 mg/kg of body weight per day.
  - If a 150-lb (70-kg) person ingested 0.1 mg of soluble uranium per day, the daily rate would be $0.1 \div 70 \approx 0.001$ mg/kg, which is below the reference dose and thus unlikely to cause adverse health effects. This would yield a hazard quotient of $0.001 \div 0.003 = 0.33$.

Hazard Index

- Sum of the hazard quotients for all chemicals to which an individual is exposed.
- A value less than 1 indicates that the exposed person is unlikely to develop adverse human health effects.

4.3.4 Accidents

The EIS considers a range of potential accidents that could occur during conversion operations and transportation. An accident is defined as a series of unexpected or undesirable events leading to a release of radioactive or hazardous material within a facility or into the natural environment. Because an accident could involve a large and uncontrolled release, such an event potentially could pose considerable health risks to workers and members of the general public. Two important elements must be considered in the assessment of risks from accidents: the consequence of the accident and the expected frequency (or probability) of the accident.

4.3.4.1 Accident Consequences

The term accident consequence refers to the estimated impacts if an accident were to occur — including health effects such as fatalities. For accidents involving releases of radioactive material, the consequences are expressed in the same way as the consequences from routine operations — that is, LCFs are estimated for the MEI and for populations on the basis of estimated doses from all important exposure pathways.

Assessing the consequences of accidental releases of chemicals differs from assessing routine chemical exposures, primarily because the reference doses used to generate hazard indices for long-term, low-level exposures were not intended for use in the evaluation of the short-term (e.g., duration of several hours or less), higher-level exposures often accompanying accidents. In addition, the analysis of accidental releases often requires evaluation of different chemicals, especially irritant gases, which can cause tissue damage at higher levels associated with accidental releases but are not generally associated with adverse effects from chronic, low-level exposures.

To estimate the consequences of chemical accidents, two potential health effects endpoints were evaluated: (1) adverse effects and (2) irreversible adverse effects (see text box). In addition, the number of fatalities from accidental chemical exposures was estimated. For exposures to uranium and HF, it was estimated that the number of fatalities occurring would be about 1% of the number of irreversible adverse effects (EPA 1993; Policastro et al. 1997). Similarly, for exposure to NH_3, the number of fatalities was estimated to be about 2% of the number of irreversible adverse effects (Policastro et al. 1997).

Health Effects from Accidental Chemical Releases

The impacts from accidental chemical releases were estimated by determining the numbers of people downwind who might experience adverse effects and irreversible adverse effects:

Adverse Effects: Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as respiratory irritation or skin rash (associated with lower chemical concentrations), to irreversible (permanent) effects, including death or impaired organ function (associated with higher chemical concentrations).

Irreversible Adverse Effects: A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system or lung damage), and other effects that may impair everyday functions.

Human responses to chemicals do not occur at precise exposure levels but can extend over a wide range of concentrations. However, in this EIS, the values used to estimate the number of potential chemical effects should be applicable to most individuals in the general population. In all populations, there are hypersensitive individuals who will show adverse responses at exposure concentrations far below levels at which most individuals would normally respond (American Industrial Hygiene Association [AIHA] 2002). Similarly, many individuals will show no adverse response at exposure concentrations even somewhat higher than the guideline values. For comparative purposes in this EIS analysis, use of the guideline values discussed above allowed a uniform comparison of the impacts from potential accidental chemical releases across all alternatives.

4.3.4.2 Accident Frequencies

Accident Categories and Frequency Ranges

Likely (L): Accidents estimated to occur one or more times in 100 years of facility operations (frequency ≥ 1×10^{-2}/yr).

Unlikely (U): Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency = from 1×10^{-2}/yr to 1×10^{-4}/yr).

Extremely Unlikely (EU): Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency = from 1×10^{-4}/yr to 1×10^{-6}/yr).

Incredible (I): Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1×10^{-6}/yr).

The expected frequency of an accident is the chance that the accident might occur while an operation is being conducted. If an accident is expected to happen once every 50 years, the frequency of occurrence is 0.02 per year: 1 occurrence every 50 years = 1 ÷ 50 = 0.02 occurrence per year. A frequency estimate can be converted to a probability statement. If the frequency of an accident is 0.02 per year, the probability of the accident occurring sometime during a 10-year program is 0.2 (10 years × 0.02 occurrence per year).

The accidents evaluated in this EIS were anticipated to occur over a wide range of frequencies, from once every few years to less than once in 1 million years. In general, the more unlikely it would be for an accident to occur (the lower its probability), the greater the expected consequences. Accidents were evaluated for each activity required for four frequency categories: likely, unlikely, extremely unlikely, and incredible (see text box). To interpret the importance of a predicted accident, the analysis considered the estimated frequency of occurrence of that accident. Although the predicted consequences of an incredible accident might be high, the lower consequences of a likely accident (i.e., one much more likely to occur) might be considered more important.

4.3.4.3 Accident Risk

The term “accident risk” refers to a quantity that considers both the severity of an accident (consequence) and the probability that the accident will occur. Accident risk is calculated by multiplying the consequence of an accident by the accident frequency. For example, if the frequency of occurrence of a facility accident is estimated to be once in 100 years (0.01 per year) and if the estimated consequence, should the accident occur, is estimated to be 10 LCFs among the people exposed, then the risk of the accident would be reported as 0.1 LCF per year (0.01 per year × 10 LCFs). If the facility was operated for a period of 20 years, the accident risk over the operational phase of the facility would be 2 LCFs (20 years × 0.1 LCF per year).

This definition of accident risk was used to compare accidents that have different frequencies and consequences. Certain high-frequency accidents that have relatively low consequences might pose a larger overall risk than low-frequency accidents that have potentially high consequences. When calculating accident risk, the consequences are expressed in terms of

LCFs for radiological releases and in terms of adverse health effects, irreversible adverse health effects, and fatalities for chemical releases.

4.3.4.4 Physical Hazard (On-the-Job) Accidents

Physical hazards, unrelated to radiation or chemical exposures, were assessed for each alternative by estimating the number of on-the-job fatalities and injuries that could occur among workers. These impacts were calculated by using industry-specific statistics from the BLS. The injury incidence rates were for injuries involving lost workdays (excluding the day of injury). The analysis calculated the predicted number of worker fatalities and injuries as the product of the appropriate annual incidence rate, the number of years estimated for the project, and the number of full-time equivalents (FTEs) required for the project each year. Estimates for construction and operation of the facilities were computed separately because these activities have different incidence statistics. The calculation of fatalities and injuries from industrial accidents was based solely on historical industrywide statistics and therefore did not consider a threshold (i.e., any activity would result in some estimated risk of fatality and injury).

4.4 UNCERTAINTY IN ESTIMATED IMPACTS

Estimates of the environmental impacts from DUF_6 conversion are subject to considerable uncertainty. This uncertainty is a consequence primarily of characteristics of the methods used to estimate impacts. To account for this uncertainty, the impact assessment was designed to ensure — through uniform and careful selection of assumptions, models, and input parameters — that impacts would not be underestimated and that relative comparisons among the alternatives would be meaningful. This goal was accomplished by uniformly applying common assumptions to each alternative and by choosing assumptions that would produce conservative estimates of impacts (i.e., assumptions that would lead to overestimates of the expected impacts). Although using a uniform approach to assess impacts can still result in some uncertainty in estimates of the absolute magnitude of impacts, this approach enhances the ability to make valid comparisons among alternatives.